INL has designed and engineered low-cost, on-board control architecture that revolutionizes robot capabilities and robot/operator relationships, by giving robots exceptional new levels of autonomy and intelligence.

Intelligence Kernel Enables Robot Autonomy

Today's mobile robots lack the intrinsic intelligence necessary to exhibit true independence and they tend to fail entirely in unstructured environments when external input is unavailable or inaccurate. INL's Robot Intelligence Kernel (RIK) addresses this fundamental challenge in one portable software package that contains a reconfigurable suite of perceptual, behavioral and cognitive capabilities. The software can be used across many different platforms, environments and tasks. RIK integrates algorithms and hardware for perception, world-modeling, adaptive communication, dynamic tasking, navigation behaviors, and search and detection.

This intelligence kernel is comprised of four layers. The kernel's foundation is the Generic Robot Architecture that provides an object-oriented framework and an application programming interface to feed data from a host of different platforms, sensors and actuators into a second-layer set of Generic Robot Abstractions. The third layer is comprised of many reactive and deliberative Robot Behaviors that take the generic robot abstractions as input. In turn, the fourth layer provides the "Cognitive Glue" that orchestrates the asynchronous firings of these behaviors towards specific application tasking.

The INL robot intelligence kernel, including hardware, software, and sensors – enhances a robot's capacity to interpret and "understand" its surroundings and supports changing levels of operator involvement. The operator can be fully in control, or the robot can be instructed to assume varying degrees of autonomy – from making sure it doesn't hurt itself to shared control where the robot selects its own route and the operator is a backseat driver – or, to full autonomy, where the operator gives high-level tasking such as "Search this building for humans!"

The intelligence kernel delivers capabilities that are analogous to that of a highly

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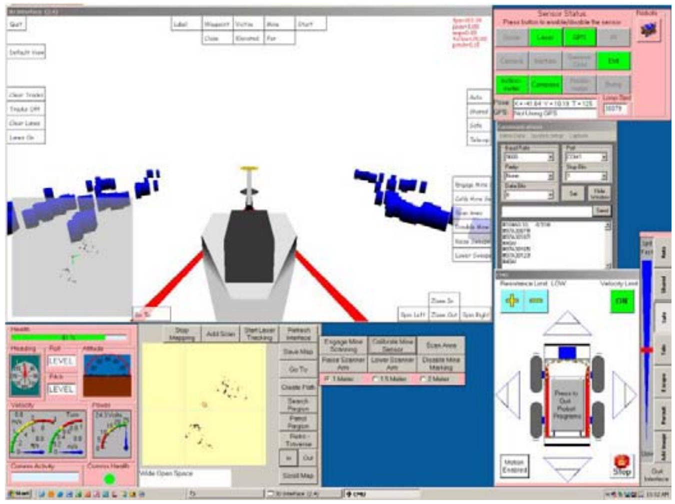

The Operator Control Interface (shown in a mine detection configuration) is comprised of a number of windows displaying information about the robot and its environment, including an easy to use computer-game-style interface.

trained police dog, permitting robots to be viewed as trusted, independent teammates rather than passive, dependent tools. The robot and the operator are enabled to reason about the task and environment. Until now, the lack of an effective shared model has been a significant impediment to having humans and intelligent robots work together.

In response to this challenge, the INL has developed a dynamic autonomy control architecture that provides a new framework for information sharing, environmental modeling, natural tasking and situation awareness. In order to support a dynamic sharing of roles and responsibilities, RIK employs a representation that allows both the human and robot to reason spatially about the world and to understand the spatial perspective of the other.

Through sensor fusion and probabilistic reasoning, the robot creates a virtual representation of its surroundings on a unique graphical Operator Control Interface (OCI) that is part of the INL system. The OCI displays a computer-game-style representation of the robot's environment that is created in real time as the robot moves throughout the real world. This game style interface, called the Virtual 3D display, has been shown to use between 3,000 and 5,000 times *less* bandwidth than a video display. When equipped with the INL RIK, robots can be tasked from around the world using a single cell phone modem or long range, low-bandwidth radio. RIK is designed to handle communication in a plug-and-play fashion and can support any serial radio device or combination of devices. In fact, RIK adapts communication output in response to changing datalink connectivity and bandwidth, insuring that critical communications are given priority. This is a significant advantage, enabling operations in more difficult environments and over much greater distances than is possible with conventional robots.

Reliable, cross-platform robot autonomy, more reliable long-distance communication, and an information-rich virtual display – possible only with the INL technology – accelerate the speed and confidence with which an operator can complete remote tasks. These unique capabilities have been shown experimentally to provide significant performance enhancements in areas including urban search and rescue, landmine detection, remote characterization of high-radiation environments, facility security, assessing hazardous spills and identifying and pursuing criminals or terrorists.

For more information

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